926,399

PATENT SPECIFICATION

DRAWINGS ATTACHED

926,399

Date of Application and filing Complete Specification: Nov. 3, 1961.

No. 39476/61.

Application made in United States of America (No. 107,568) on May 3, 1961.

Complete Specification Published: May 15, 1963.

Index at acceptance:—Class 83(1), F(3A:11Y1:12A).
International Classification:—B22c.

COMPLETE SPECIFICATION

Method of Manufacturing Complex Air Cooled Turbine Components

We, HOWE SOUND COMPANY, a Corporation organised under the laws of Delaware, United States of America, of 500 Fifth Avenue, New York, New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the production of turbine components such as turbine blades and vanes. It relates more particularly to the production of such components wherein pattern elements are provided which result in the formation of passages within the turbine components.

In the propulsion of high speed aircraft, which employ as part of their propulsion systems turbine blades and vanes and similar components, problems have arisen relating to the materials employed in the production of these components. Since the components must be capable of withstanding the extremes of high temperature and high stress, the extent to which materials now in existence could be employed is limited.

Designers and manufacturers have utilized high melting point metals such as titanium, zirconium and hafnium and alloys thereof in an attempt to cope with the high temperature and high stress conditions. Due to the limitations of these materials and their alloys, however, a further approach has evolved relating to the design of the components, the goal being the achieving of designs capable of decreasing the effect of the temperature and stress.

In one of the designs evolved, cooling passages have been provided in the turbine components immediately adjacent the exposed surfaces thereof. In this manner, the heat to which the components were subjected could be more rapidly dissipated, and therefore, the high stresses would not be alone sufficient to cause failure of the components. In the design of components with air cooling passages of this type, it was found desirable to achieve maximum surface area in order to conduct heat away while at the same time not structurally weakening the components.

Various techniques have been devised relating to the use of cores in conjunction with casting operations employed in the manufacture of the components.

It has been found that in the production of the castings with the cooling passages, it has been extremely difficult to maintain true alignment of the thin elongated cores in the moulds produced. As a result, prior procedures have been prone to a high scrap rate. The difficulties arise in part due to the extremely high casting temperatures of the alloys used in the production of turbine components. Thus, where quartz tubes with an incipient softening point of 2150° F are employed as the core materials, there is a natural tendency for the cores to distort or slump at the casting temperatures and become misaligned.

It therefore becomes a general object of this invention to provide an improved method for the production of turbine components with cooling passages contained therein.

According to the present invention in a pattern element adapted for the production of turbine components with elongated passages located therein, said pattern including disposable means located therein in a position corresponding to the desired position of said passages, the improvement comprising supporting means located within said pattern for supporting said disposable means, said supporting means having a first portion through which said disposable means are passed and a second portion extending beyond the outer periphery of said pattern.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings in which:

Fig. 1 is a top plan view of a pattern ele-

ment characterized by the novel concepts of this invention;

Fig. 2 is an enlarged sectional view taken about the line 2—2 of Fig. 1;

Fig. 3 is an enlarged sectional view of a pattern element of the type shown in Fig. 2 provided with a ceramic shell mould;

Fig. 4 is an enlarged sectional view of a completed turbine component produced in accordance with the inventive process;

Fig. 5 is a detailed view of an eyelet or guide element associated with a core member in accordance with the practice of this invention; and

Fig. 6 is an alternative form of an eyelet or guide element characterizing the present invention.

Referring to the drawings, there is shown therein a pattern element 2 conforming in its outer dimensions to the desired dimensions of a turbine component 4. The component 4 is to be provided with passages 6 adapted for the passage of cooling fluids for the purposes hereinbefore described.

The patterns 2 are provided with disposable core means 8 which are positioned within the pattern in the desired positions of the passages to be formed in the component 4. The cores may be composed of various materials and may be hollow as shown to permit introduction of fluid for eating away of the core material after casting of the metal.

Provided intermediate the ends of the pattern and associated with the cores 8 are a plurality of guides or eyelets 10. The guides comprise an eye portion 12 adapted to snugly receive the cores 8 and an extension 14 adapted to pass beyond the outer periphery of the pattern material. As indicated, the eye portion 12 may form a continuous circle, or have an open portion as shown in Fig. 6. It will be apparent that the particular designs shown are exemplary only and other designs capable of functioning in the disclosed manner are contemplated.

In considering the above, it will be obvious that there is achieved by means of the elements 10 support for the cores 8 intermediate the ends thereof. This intermediate support will be in addition to the support which can be accomplished at the ends of the cores by an associated mold. When a mold is formed about the pattern element, as exemplified by the ceramic shell mold shown in Fig. 3, the extensions 14 of the guides 10 become embedded in the mold body and provide secured positioning of the guides 10, and accordingly, the cores 8, when the pattern material is removed from the mold.

The instant invention is peculiarly suitable for adaptation into ceramic shell molding processes. It will be understood, however, that various other molding techniques are suggested for use in accordance with this invention.

In a typical process employing shell molding techniques, a wax pattern will be formed with the guides or eyelets 10 included therein. This may be accomplished in any obvious manner such as by providing insert holes for the extension 14 in the walls of a wax injection die. Alternatively, the portions of the wax pattern holding the guides 10 may be formed separately and then assembled into a unitary pattern. Through proper fixturing and tooling, passages are formed for the cores 8; for example, by the use of tungsten rods conforming to the desired diameter of the passages.

After insertion of the cores, a ceramic shell molding process comprising a series of dip coats is commenced and the shell mold 16 results.

After removal of the wax pattern, the cores 8 are supported at their ends by the surrounding shell mold and intermediate their ends by the guides 10. Injection of the molten metal will not cause distortion and misalignment of the cores during the time necessary for solidification of the cast metal. This is true even where cores such as quartz with low relative incipient softening points are employed. With the added support of the guides 10, there is a sufficient duration for accurate solidification of the molten metal without danger of loss of precision.

During the casting operation, it is necessary that the eyelets or guides be dissolved in order that there will be no dissimilar characteristics in the castings which would detract from the physical properties thereof. For this reason, the guides or eyelets are composed either of the same alloy as that being cast whereby they will be dissolved during casting, or of a metal or alloy which will likewise dissolve but will not result in harmful dissimilarities in the ultimate casting. Where the guides or eyelets 10 are composed of the same alloy as that being cast, the metal must be cast at a temperature which will provide sufficient latent heat for the fusion of the guides. In the case of the small eyelets necessary for the production of the passages in turbine components, normal casting temperatures will be sufficient for this purpose.

Where metals or alloys of a composition different than the alloy being cast are employed for the eyelets, it is necessary to provide a composition which will dissolve during casting. It is suggested that compositions containing the same ingredients as the metal being cast but in a lower melting point combination be employed for the manufacture of the eyelets or guides. Such alloys would be more readily fused and would have no significant effect on the properties of the components adjacent the cooling passages. As a further example, in the case of casting components of nickel base alloys, pure nickel is contemplated as a feasible material for the guides or eyelets 10.

In some dewaxing processes, temperatures

in the range of 1600° to 2000° F. are reached. This temperature would tend to oxidize the eyelets during the dewaxing and it is therefore contemplated that a coating of an oxidizing resistant material such as chromium or aluminum be provided on the eyelets at least prior to assembly.

The extensions 14 of the eyelets which function to hold them in position with respect to the mold, can be readily machined off the final casting, as suggested by the dotted line portions in Fig. 4.

It will be understood that various modifications may be made in the above disclosed procedure for the production of turbine components, which modifications provide the characteristics of this invention without departing from the scope thereof, as defined in the following claims.

WHAT WE CLAIM IS:—

1. In a pattern element adapted for the pr[illegible] duction of turbine components with elongate passages located therein, said pattern includ ing disposable means located therein in a position corresponding to the desired position o[illegible] said passages, the improvement comprising supporting means located within said pattern for supporting said disposable means, said supporting means having a first portion through which said disposable means are passed and a second portion extending beyond the outer periphery of said pattern.

2. A pattern element according to the preceding claim wherein said disposable means comprise elongated hollow rods and said supporting means comprise eyelets, said first portion having an eye portion through which said rods pass.

3. A pattern element according to claim 2 wherein at least two of said eyelets are provided for supporting each of said rods, said eyelets being located in spaced relation in portions of said pattern intermediate the ends thereof.

4. A pattern element according to the preceding claims wherein said supporting means is composed of the same metal as the metal being cast.

5. A pattern element according to the preceding claims wherein at least the first portion of said supporting means is provided with an oxidizing resistant coating.

6. A pattern element according to the preceding claims in which the pattern is formed of a wax.

7. A pattern element according to the preceding claims in which the disposable means comprises elongate rods having a diameter corresponding to the desired diameter of the passages.

8. A pattern element according to the preceding claims in which the supporting means comprise eyelets having eye portions through which the rods are passed for support of the rods and in which the eyelets have extensions thereon extending beyond the outer periphery of the pattern.

9. A pattern element according to Claim 8 in which at least the eye portion of the eyelets is provided with an oxidizing resistant coating.

10. The combination of a ceramic shell and a pattern element according to the preceding claims wherein the supporting means extend into the ceramic shell built up about said pattern whereby said supporting means are maintained in position by the ceramic shell when the pattern element is removed.

11. A method for the production of turbine [illegible]ponents with cored passages therein com[illegible] the steps of producing a pattern [illegible]ng to any of the preceding claims [illegible]isposable means located therein in a [illegible] corresponding to the desired position [illegible] passages and having supporting means [illegible] within said pattern for supporting said [illegible]ible means, said supporting means hav[illegible] first portion through which said dispos[illegible] means are passed and a second portion extending beyond the outer periphery of said pattern, building up a ceramic shell mold onto said pattern whereby said extending second portions become embedded and secured in said shell mold, removing the pattern material from said mold whereby said disposable means are supported at least in part by said supporting means, casting metal into said mold whereby said supporting means and disposable means [illegible] embedded in said material and separating [illegible] solidified casting from the mold.

[illegible]. A method according to claim 11 includ[illegible] step of removing the extending second [illegible]s from the surfaces of said casting and [illegible]ng said disposable means from said [illegible].

[illegible] pattern element substantially as here[illegible]bed, with reference to the accompany[illegible]wings.

[illegible]. A method for the production of turbine components with cored passages therein, substantially as herein described, with reference to the accompanying drawings.

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Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press (Leamington) Ltd.—1963. Published by The Patent Office, 25 Southampton Buildings, London, W.C.2, from which copies may be obtained.

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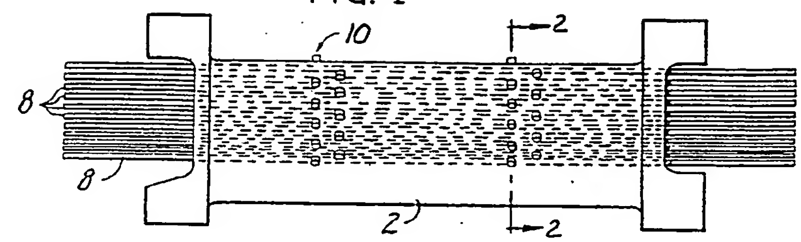
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

FIG. 1



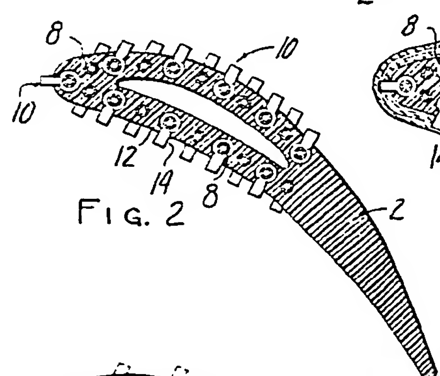


FIG. 2

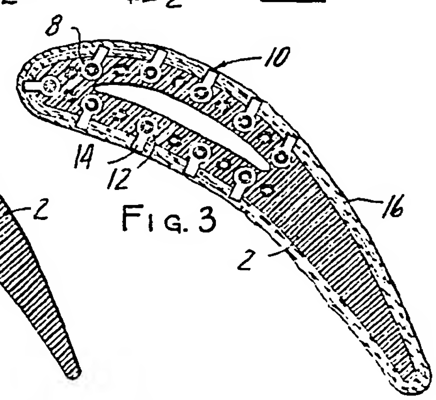


FIG. 3

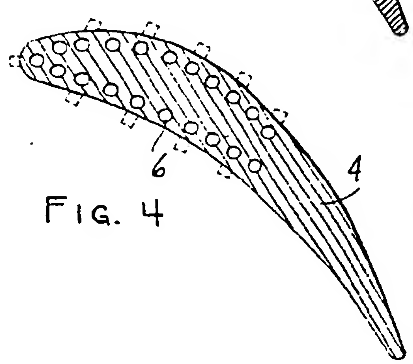


FIG. 4

FIG. 5

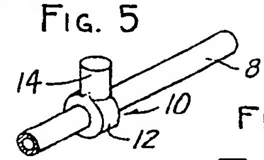


FIG. 6